Abstract

Selecting the design ground motion parameters for future earthquakes is a challenging task in earthquake engineering. The intensity of ground shaking depends on the physics of the earthquake process, the seismic wave characteristics, damping and density of the elastic medium. The important parameters commonly used in engineering application are Peak Ground Acceleration (PGA) and response spectrum. This thesis addresses the question of how the above parameters can be rationally estimated for a very highly
Seismic zone like North Eastern Region of India (NERI).
A detailed literature review and necessity of engineering seismic hazard estimation for
NERI is presented in **Chapter** 1.The geological and seismotectonic setup of NERI has been described. The seismic status of NERI has also been discussed in this chapter.

In Chapter 2, three region specific seismological model parameters namely stress drop, quality factor and soil (kappa factor) parameters are estimated. These earthquake model parameters represent the source, path and site parameters respectively. Reliable estimates of these parameters for NERI have been presented here for the first time. The model parameters are computed for this region from time histories of past earthquake records. These parameters are used in developing reliable ground motion attenuation relation for NERI.

In chapter 3, the thesis proposes a new attenuation relation for ground motion at the bedrock level for NERI. This region has very few recorded strong motion data though it has experienced more than 2000 earthquakes in the past 600 years. Attenuation relations for PGA and 5% damping Spectral acceleration *(Sa)* have been developed for NERI by stochastic simulation of ground motion based on the seismological model of Boore (1983, 2003).

Seismological model parameters namely stress drop, quality factor and kappa factor calculated in chapter 2 are used in simulation of ground motion samples. Twenty thousand ground motion samples are simulated for different range of magnitudes and hypocentral distances. These simulated ground motion samples are used to derive attenuation relation using two stage regression analyses. The developed regional attenuation relation is validated with available recorded data.

In chapter 4, the attenuation relation developed in the previous chapter is utilized to carry out Probabilistic Seismic Hazard Analysis (PSHA) for two important cities in NERI. Seismic hazard for 100, 500 and 2500 year return period for Guwahati and Shillong cities has been calculated considering all the seismotectonic sources within 300 'km radius around these two cities. Limited PSHA results are presented for eight important cities namely Aizawl, Agartala, Silchar, Karimganj, Jorhat, Itanagar, Kohima and Imphal of NERI corresponding to faults within the boundaries of India. Earthquake hazard microzonation maps at the bedrock level for a region of 200 km X 200 km centered around Guwahati city have been prepared in this chapter.

In chapter 5, the results of chapter 3 and 4 are further used to compute city level hazard for Guwahati accounting for local site effects. For studying soil effects borehole data from 508 sites have been collected. Shear wave velocity has been estimated empirically. Based on this the city is divided in to four broad zones. PSHA has been carried out for the sites including the effect of soil layering.

For routine design of structures, PGA and the response spectrum are sufficient. However, for very important structures such as bridges, dams and industrial plants ground motion histories are required in time domain. In **chapter 6,** the ground motion time histories for high magnitude earthquakes in NERI are simulated based on record of small events using Empirical Green's function (EGF) approach.

Simulated ground motion samples valid for Assam Valley region, Shillong Plateau region and Eastern Himalayan region corresponding to magnitude Mw= 8.5 are presented. Similarly simulated ground motion records applicable for Arakan Yoma Belt region corresponding to magnitude Mw= 8.0 are presented. Also, simulated ground motion samples valid for Surma Valley region corresponding to magnitude *Mw*= 7.5 are presented. In the present study, simulated high magnitude strong motion records obtained by EGF approach have been compared with those obtained from the attenuation relation developed in chapter3.

A summary of the work done in this thesis and a few suggestions for further research are presented in **chapter 7.**

The data of past earthquakes used in this thesis for hazard analysis is presented in the **Appendix.**